NIRMA UNIVERSITY

Institute:	Institute of Technology
Name of Programme:	M.Tech. in Electronics & Instrumentation Engineering (Robotics and Artificial Intelligence)
Semester:	II
Course Code:	6ME873ME25
Course Title:	Soft Robotics
Course Type:	Elective Course – II
Year of introduction:	2025-26

L	T	Practical component				C
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Course Learning Outcomes (CLOs):

After successful completion of the course, student will be able to –

1. outline the applications of soft robots, (BL2)
2. design the soft robot using soft mechanisms, (BL3)
3. select the suitable soft materials for soft actuators and sensors, (BL5)
4. develop the kinematic and control model for soft actuators. (BL6)

Unit	Contents	Teaching Hours (Total 30)
Unit I	**Introduction to soft robot** Introduction, science of soft robot, configuration of soft robot, history, bio-inspiration, future of soft robot	04
Unit II	**Design of soft robot** Soft mechanism: deformable mechanism, continuum elastic and bistable mechanism, biological mechanism, soft manipulation and locomotion, soft robot hand, peristaltic locomotion, aerial flight with soft components, aquatic swimming with soft fins,	08
Unit III	**Soft materials** Basics of polymers, structure and classification of polymers, basic concept of soft materials, Elastomers, Hydrogel, fabrication of soft robot, biological materials, biological cell, biodegradable soft material, materials intelligence	06
Unit IV	**Soft actuators and sensors** Flexible sensors, tactile pressure sensors, temperature sensor, stretchable wires, thin-film transistor, softness of the actuator, types and classification of actuator, fluidic actuators, electroactive polymer actuator, thermomechanical actuator, bio-actuator	08

Unit V	**Modelling and control** Physics of soft bodies, motion and deformation, Rod theory kinematics, statics, nonlinear dynamic in simple mechanical system, concept of control, positioning and orientation control.	04

Self – Study: The self-study contents will be declared at the commencement of semester. Around 10% of the questions will be asked from self-study contents.

Suggested Readings/References:

1. Koichi Suzumori, Kenjiro Fukuda, Ryuma Niiyama, Kohei Nakajima, The Science of Soft Robot – Design, Materials and Information Processing, Springer
2. Gareth J. Monkman, Soft Robotics, Bentham Books
3. Thrishantha Nanayakkara, Handbook on Soft Robotics, Spinger
4. Matthew Borgatti, Kari Love, Soft Robotics, Maker Media, Inc.

Suggested List of tutorials:

1. Design a simple soft robotic structure using CAD software
2. Perform a finite element analysis (FEA) of a soft structure
3. Create a soft robotic finger using silicone molding
4. Build a soft actuator controlled using pneumatic/hydraulic pressure
5. Simulate electroactive polymer (EAP) actuator behavior using MATLAB/Simulink
6. Create a flexible pressure sensor using conductive fabric or liquid metal
7. Implement a PID control strategy for soft robot motion simulation
8. Model and simulate worm-like locomotion in a soft robot
9. Simulate the fluid-structure interaction of a soft fin in water
10. Design and simulate a soft robotic gripper
11. Implement Rod theory-based kinematics for soft robots
12. Train a soft robot to perform a task using RL

L = Lecture, T = Tutorial, P = Practical, C = Credit

w.e.f. the academic year 2025 - 26 and onwards